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ENGINEERING OUTLOOK

AT THE UNIVERSITY OF ILLINOIS

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1960 ENGINEERING RESEARCH SUMMARIZED

The 1960 research program of the Engineering Experiment Station, with a total budget of nearly 7½ million dollars, is reported in detail in the *Summary of Engineering Research 1960*. During fiscal 1960, 266 projects were sponsored by 35 private companies, 19 industrial associations, 5 private foundations, and 52 federal and state agencies. During this same period there were approximately 350 investigations under way, including both sponsored and University-supported research.

Of the total budget, approximately $5,613,000 came from various federal government sources, $637,000 from industry, private foundations, associations, and operating agencies of the state of Illinois, and $1,213,000 from the general funds of the University. The role of the Engineering Experiment Station as the coordinating agency is described in the introduction of the booklet.

The 13 engineering departments discussed include Aeronautical, Agricultural, Ceramic, Chemical, and Civil Engineering; the Coordinated Science Laboratory; Electrical, General, Mechanical, Mining and Metallurgical, and Nuclear Engineering; Physics; and Theoretical and Applied Mechanics. The Digital Computer Laboratory and various supplementary research facilities that are not in the College of Engineering are included because they play an important role in many engineering research projects.

Each project is summarized, and a list of publications resulting from the research is included. Researchers and sponsors are identified for each project.

This material is compiled into a 144-page booklet which is free of charge. It is available upon request from the Engineering Publications Office, 114 Civil Engineering Hall, University of Illinois, Urbana, Illinois.

PLATO JOINS THE FACULTY

The responses made by a student tell the teacher how well the student is comprehending and how fast he can go. This "feedback," important to us in everything we do, is doubly important in the student-teacher relationship, where efficiency depends entirely on the understanding of each by the other. The principle of feedback has been incorporated in a teaching machine system recently constructed by the University's Coordinated Science Laboratory.

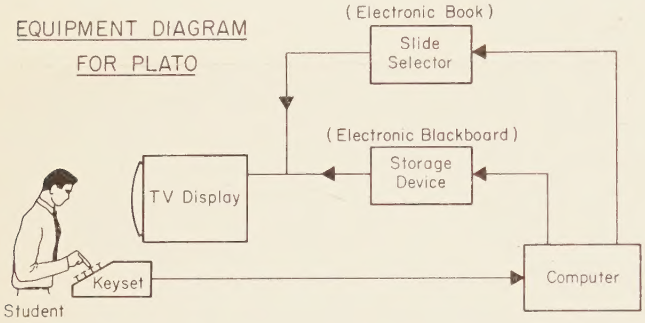
The development of the machine, which is named PLATO (Programmed Logic for Automatic Teaching Operations), is directed by Professors D. L. Bitzer and P. G. Braunfeld. The two main objectives of the project are, first, to design and build equipment enabling student and machine to communicate with each other, and second, to write and evaluate programs that control the teaching operation within the computer. Basically the present equipment, which uses the ILLIAC computer for brainpower, consists of a slide reservoir, a storage tube which will permit material given by the student or by the computer to be displayed with the slides, the screen of a closed-circuit television system, and the student's control panel. It might be said that the device is an electronic blackboard and textbook with a talent for prompting.

PLATO, like its namesake, asks questions and makes men think. Through feedback from the student, it adjusts to individual ability and speed of comprehension; it will allow the exceptional student to progress at high speed, while a less capable one can proceed at a slower rate. Only the facts which would allow the superior student to solve the problem are initially given. A less advanced student, through his control panel, can ask for more information. He can continue to get more facts, or even review early facts, until he solves the problem. The control panel is so designed that the student can use the computer for calculations necessary for solving problems. At the end of the sequence the machine issues a card containing complete information on the student's performance and results.

The feedback between this machine and the student is similar to the feedback between a human teacher and student. The present equipment will teach one student at a time, and has been programmed to give instruction in mathematics and French grammar. Ultimately it will be modified to teach many students at the same time (still giving individual attention to each), and it will be programmed to teach other subjects. There is no foreseeable difficulty in having it teach a number of students at once because each student relationship requires only a tiny fraction of the computer's "attention."

The subject-matter PLATO could teach varies greatly. Through slides, it can "lecture," give textual instruction, and show any sort of graphic or explanatory material. One eventual goal is to program it to teach students how to program computers. This would be good for two reasons: all engineering students will need training in computer operation in the future and teaching it by computer would not only give the student the necessary theory but also practical experience in computer operation.

EQUIPMENT DIAGRAM FOR PLATO



PLATO received its first public demonstration in March at the President's Faculty Conference on "improving our educational aims in the 60's." ILLIAC, of course, remained on campus, but the rest of the equipment was 30 miles away, the site of the conference and the demonstration. Educators present agreed that PLATO is significant not only because of its ability to react to the student's individual abilities but also because it offers a method of scientifically studying and ultimately controlling the variables which affect learning speed.

SUMMER TRAINING PROGRAM

To stimulate interest in engineering and science among outstanding high school students, and to let them see for themselves the engineering and science program offered by their state university, the University of Illinois is again conducting a six-weeks' Summer Institute in Science and Engineering. The program, sponsored by the National Science Foundation, will be held on campus from June 12 through July 21. Approximately 40 students who will be Illinois high school seniors in the fall of 1961, ordinarily those who are in the upper 10 per cent of their classes, will be eligible for the program. The deadline for applications is May 1, 1961.

Announcement brochures have been mailed to high schools throughout the state. Application forms may be obtained by writing Professor J. S. Dobrovolny, Director, 117 Transportation Building, University of Illinois, Urbana, Illinois.

ASCE HYDRAULICS CONFERENCE

The rains in the plains of central Illinois are rare in August, but there will be plenty of water on the University of Illinois campus when the Hydraulics Division of the American Society of Civil Engineers holds its Tenth Annual Hydraulics Conference here August 16-18. Co-hosts of the national meeting are the University of Illinois and the Central Illinois Section of ASCE.

Since August may be hot as well as dry, the six half-day technical sessions will be in the air-conditioned auditorium of Gregory Hall. The expected 300 conference participants will be housed in recently constructed dormitories on the campus.

The technical sessions will feature papers by nationally known experts in the fields of ground water hydrology, surface water hydrology, hydraulic structures, sedimentation, hydromechanics, hydrometeorology and flood control, and a tour of the Illinois State Water Survey Meteorology Laboratory at the University Airport.

A field trip on the morning of August 19 will take the group to the National Petro-Chemicals Corporation's modern plant at Tuscola, Illinois. The trip will include inspection of the plant's unique water supply and disposal systems.

While the engineers consider technical matters, their wives and children will have their own field trip, an all-day Lincoln Tour on Friday, August 18, in air-conditioned buses. The tour will go to Springfield and New Salem State Park. The group will visit Lincoln's Home and Tomb and the restored village of New Salem, where Lincoln lived and worked as a young man. During the three-day meeting, young people will conduct their own hydraulic studies at the new Champaign Park swimming pool and Lake of the Woods.

Additional information may be obtained by writing to Professor J. M. Robertson, 125 Talbot Laboratory, University of Illinois, Urbana, Illinois.

THE HIGHEST HURDLE: MATERIALS SELECTION

How can an engineer best contribute to new scientific and engineering achievements? If you ask the leaders in such fields as missiles and nuclear power, their answer is: "Materials problems are the greatest obstacles to progress in our field; we need men who can solve these problems." And so it goes, from building mousetraps to nose cones, transistors to tin cans; finding the material that will economically and functionally satisfy the requirements of the job is the highest hurdle on the road to accomplishment.

The most versatile of all materials are metals, and the role of the metallurgist is critical and challenging. It is his job to design and produce the right alloy for each of the multitude of different applications in which metals are asked to serve.

In order to handle these assignments, the metallurgist must understand the structure of atoms, the fundamental building blocks of all materials. He must know how they are assembled into crystalline structures, and how defects in these structures affect the materials they make up. He must further study how the way these crystals are joined together affects the properties of the metal. Then he must learn how variables such as composition, melting and casting procedures, heat treatment, and deformation affect the properties of the finished metals.

The metallurgist must understand the ways in which metals fail — wear, corrosion, creep, fatigue, fracture — and from this knowledge, design metals which are able to resist service failures.

There is a pressing need for metallurgists in all phases of industry today. The number of metallurgists graduated from just one large Russian university equals the total number being graduated by all schools in this country.

The metallurgy curriculum at the University of Illinois is built around a core of physics, chemistry, mathematics, and metallurgical engineering courses. Ample freedom in the selection of additional courses allows the student to follow his personal interests, whether they be along lines of scientific research or preparation for a career in production operations in industry.

The courses are taught by a large staff whose interests cover the broad range of topics in the field of metallurgy. The department has a strong graduate program and extensive research activities, some of which are sponsored by industry. Many undergraduates find part-time employment by helping with this research.

Those interested in further information about the field of metallurgy or the educational programs in that area of study at the University of Illinois are urged to write to Professor T. A. Read, Head, Department of Mining and Metallurgical Engineering, 311 Ceramics Building, University of Illinois, Urbana, Illinois.

DEFLECTIONS IN ELASTIC SHELLS

Engineering Experiment Station Bulletin 458, *Theory of Non-Homogeneous Anisotropic Elastic Shells Subjected to Arbitrary Temperature Distribution,* by R. E. Miller, is now available for distribution. This is a general theory for shells that are homogeneous through the thickness but otherwise unrestricted in homogeneity and isotropy. The theory is specialized for arbitrary cylinders, circular cones, spheres, and axially symmetrical orthotropic shells of revolution. The price of the 36-page bulletin is one dollar per copy.

ENGINEERING AND AGRICULTURE

Although agriculture is both one of the world's oldest and largest industries, most of the technology to increase the agricultural worker's output has been developed since the turn of the century. In 1900, each agricultural worker produced food and fiber for only seven people. By 1940, the food and fiber output of each worker was sufficient for 11 people. Continued mechanization of farming enables today's agricultural worker to produce for 24 people. Very few industries can boast of doubling the output per worker in 20 years.

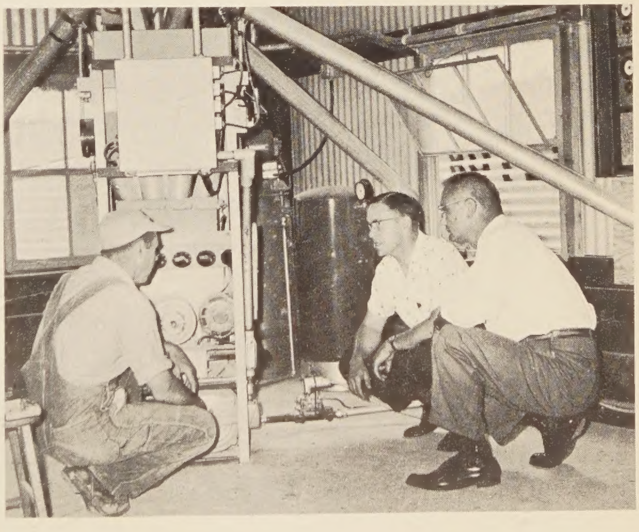
The application of engineering has been responsible for much of the rapid increase in agricultural production but many challenging problems remain unsolved. A large majority of agricultural problems have engineering implications and can best be solved by agricultural engineers since they are trained in engineering principles and also to understand agriculture.

A recent project to decrease the labor involved in feeding poultry was conducted by agricultural engineers at the University of Illinois. The objective of this project was to develop an automatic distribution system in which feed could be piped to the poultry feeders in much the same way water is piped to the waterers.

After considerable research in the laboratory to establish design characteristics, an automatic system for conveying feed through a one-inch diameter pipe was installed on a turkey and poultry farm in Peoria County, Illinois. Each year approximately 14,000 turkeys and 30,000 roasting chickens are raised on the farm.

The feeding system consists of bulk storage bins, an

Automatic grinding, conveying, and feed-line switching may someday distribute feed like water on many farms. This photograph shows the control panel and some of the equipment which make up the completely automatic feed handling system for 14,000 turkeys on the Warren Frye turkey and poultry farm in Peoria County. Frye, left, discusses the system with local agricultural engineers.



automatic hammer mill for mixing and grinding, and a medium-pressure pneumatic conveyor. The system conveys feed at a rate of 1,200 pounds per hour up to a distance of 390 feet through one-inch rigid electrical conduit with 32 cubic feet of air per minute operating under 7½ pounds of pressure per square inch. The grinder and conveyor each require approximately two kilowatts of electric power. The system has been in continuous service since it was installed in June, 1959, and has processed as much as six tons of poultry ration in a single day.

Automatic distribution of feed to several locations with pneumatic equipment is only possible through the development of controls and equipment which can work together to form a satisfactory system. Once such a system is developed, it is capable of unsupervised 24-hour-a-day operation.

This pneumatic equipment is but one example of many recent developments in farm engineering. It takes only a little thought to imagine what engineering may be doing for agriculture in the near future. Meeting the needs of modern agriculture offers the engineer a great challenge and unlimited opportunities for creativeness.

TEACHING COMPUTER USE TO UNDERGRADUATES

Two common themes in many *Outlook* stories have been speed and complexity, problems that contribute to the difficulties inherent in the engineer's work. These factors sometimes complicate projects to such an extent that solutions would be impossible without the engineer's invaluable assistant, the computer. The computer offers help in two ways: it serves as a "super slide rule," permitting mathematical computations in far less time than otherwise possible; and it serves as a decision maker in operating systems on comparisons of stored and entering data. These two basic functions make it an essential engineering tool. For this reason the College of Engineering is developing plans to teach computer use to all undergraduate students.

Such a teaching program will eventually include about 1,000 students a year, or 500 per semester. Computer facilities on the campus (see *Outlook,* March, 1961) are extensive enough to handle such a load. In addition to the ILLIAC and an IBM 650 now in use, ILLIAC II, an ultra high-speed general purpose computer, is presently being designed and built. ILLIAC II, when completed, is expected to free ILLIAC for this instruction program.

A pilot course for approximately 75 students is planned for the fall of 1961. This is expected to grow gradually over a two-year period until the course is required for all engineering students by the fall of 1963. The three-hour course is planned to consist of five basic topics: elementary machine organization; problem formulation, programming, and problem oriented languages; numerical analysis; machine languages, properties, and programming; and applications of computers. Later in his college career the student will be able to use the computer facilities for solving complex problems in his advanced courses.

A safe (but perhaps uncomfortable) assumption is that tomorrow's world will be more high-speed and complex than today's; if so, computers will assume an even more significant role in man's affairs. This new educational program in the College of Engineering will help prepare the U. of I. engineering graduate to face the complexities of modern engineering practice by giving him an introduction to that indispensable tool, the computer.

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